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(72) Inventors:
• **Knipström, Leif**
8408 Winterthur (CH)
• **Hangl, Gerhard**
8404 Winterthur (CH)
• **Kyratos, Andreas**
8005 Zürich (CH)

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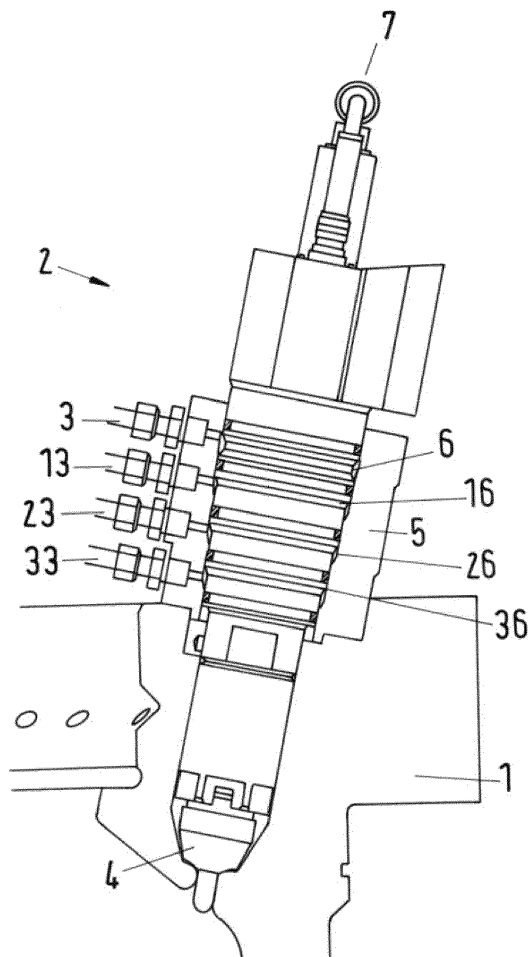
(74) Representative: **Sulzer Management AG**
Patentabteilung / 0067
Zürcherstrasse 14
8401 Winterthur (CH)

(71) Applicant: **Wärtsilä Schweiz AG**
8401 Winterthur (CH)

(54) **A fluid injection device**

(57) A high pressure fluid injection device (2) for a common rail system for a large internal combustion engine comprises a first connection element (7) for supplying high pressure fluid provided by a common rail system to the fluid injector (4) and at least a second connection element (3) for supplying a low pressure fluid to the fluid injector. The fluid injection device includes a collector element (5) connectable to the fluid injector (4), whereby the collector element contains the second connection element (3) and the third connection element (13) and the fluid injector (4) is in operation engaged with the collector element (5) to provide a fluid passage (6, 16, 26, 36) for the low pressure fluid.

Fig.2



Description

BACKGROUND OF THE INVENTION

[0001] The invention relates to a fluid injection device. The invention further relates to a high pressure fluid connection arrangement to a fluid injection device in a common rail system for a large internal combustion engine.

[0002] The invention further relates to a cylinder arrangement for an internal combustion engine, a method for operating an internal combustion engine as well as to an internal combustion engine.

BACKGROUND ART

[0003] The person skilled in the art knows a great variety of different types of reciprocating piston combustion engines, such as two-stroke or four-stroke trunk piston engines used in a variety of vehicles like ships, cars, aeroplanes or for example large diesel engines for ships or stationary units for the production of electrical power.

[0004] In this specification the term "large internal combustion engine" refers to such engines that are used, for example, as main propulsion engines or auxiliary engines in ships or in power plants for the production of heat and/or electricity.

[0005] In a known arrangement a pipe for feeding high pressure fuel from a common rail system into an injector is directly connected with fuel injection device. Furthermore plurality of pipes for feeding control fluid or a cooling fluid or a lubricant to the fuel injection device has to be provided.

[0006] A common rail fuel injector may typically need several different separate pipe connections for supply and return of media at relatively low pressures (typically at 0 -10bar pressure). For an injector cooled with engine lubricant, it may need one lubricant connection for the supply thereof, one lubricant connection for the return, one connection for the return of the control fuel and possibly one connection for a mixed leakage of lubricant and fuel. If the fuel injection device has to be disassembled for maintenance, each of these connections has to be disassembled individually. The exchange of injector becomes more laboursome due to the presence of a plurality of pipe connections to the injector.

[0007] It is known in the field of four stroke medium speed engines that the lower pressure connections can be arranged in the cylinder head. The low pressure connections are positioned at different heights and are separated by O-rings. This solution requires the machining of a bore in the cylinder head for each of the required connections. Thus, for supply and return of a cooling fluid and for a leakage fluid already three bores have to be machined. Thereby the manufacturing cost of the cylinder head can be considerably increased.

[0008] An object of the invention is to provide a new connection arrangement, which solves the above mentioned problems of the prior art. It is also an object of the

invention to provide a reliable connection arrangement with uncomplicated construction. A further object is to provide an arrangement which makes it possible to handle and control any leakage of any of the process fluids.

BRIEF SUMMARY OF THE INVENTION

[0009] The objects of the invention can be obtained by the features of claim 1. Advantageous embodiments of the invention are subject of the dependent claims.

[0010] A high pressure fluid injection device for a common rail system for a large internal combustion engine thus comprises a first connection element for supplying a high pressure fluid provided by a common rail system to the fluid injector and at least a second connection element for supplying a low pressure fluid to the fluid injector. The fluid injection device includes a collector element connectable to the fluid injector, whereby the collector element contains the second connection element and the fluid injector is in operation engaged with the collector element to provide a fluid passage for the low pressure fluid. The fluid injection device can be configured in particular as a fuel injection device. The fluid injector can be configured in particular as a fuel injector.

[0011] In an embodiment, the collector element contains at least a third connection element for a further low pressure fluid. The collector element can also contain a fourth connection element. Even more than four connection elements can be connected to the collector element. If the collector element contains a second and a third connection element and possibly further connection elements, the exchange of a fluid injector is as simple as for the above-mentioned case of a single connection element. Advantageously, the collector element is configured as a sleeve. Such a sleeve is easy to manufacture and in particular it is possible to use sealing elements, in particular circumferential sealing elements to seal the fluid containing passages to the fluid injector to the environment. In the same way a circumferential sealing element can be provided between two fluid containing passages to the fluid injector, which contain different fluids which should not be mixed.

[0012] In an embodiment, the sleeve is of cylindrical shape and has a bore of cylindrical shape. In another embodiment, the sleeve has a central bore of at least partial conical configuration. Under partial conical configuration it should be also comprised a stepped design, which includes cylindrical sections of several different diameters. In a particular preferred embodiment the smallest diameter is located closest to the injection nozzle. In particular the surface of the central bore can be of a conical shape. The conical shape is advantageous as a fluid injector of a corresponding conical shape can be fit in a precise way into the central bore.

[0013] In an embodiment the high pressure fluid has a pressure range of 600 to 2000 bar. The high pressure fluid can be in particular a fuel, such as a diesel fuel.

[0014] In an embodiment, the low pressure fluid has a

pressure of at most 10 bar. The low pressure fluid is in particular one of a lubricant or a cooling fluid or a control fluid.

[0015] For a control fluid, the pressure range is from about 1 bar up to and including 10 bar. For a lubricant, the pressure range is from about 6 bar up to and including 10 bar gauge pressure. For a low pressure fluid, which comprises a leakage fluid, the pressure range is from about 1 bar up to and including 10 bar gauge pressure.

[0016] the fluid injector is removable from the collector element according to any of the preceding embodiments by simply extracting the fluid injector from the bore in the collector. Thus, the fluid injector can be disconnected in a single step in a surprisingly simple way which additionally only requires the high pressure pipe to be removed and the bolts for holding the injector.

[0017] In an embodiment, an internal combustion engine includes a cylinder, in which a piston is arranged to be movable along a longitudinal cylinder axis to and fro between a top dead centre position and a bottom dead centre position. In the cylinder a combustion chamber is defined by a cylinder cover, by a cylinder wall of the cylinder and by a piston surface of the piston including a high pressure fluid injection device in accordance with one of the preceding embodiments. The internal combustion engine can be at least one of a crosshead engine, in particular a crosshead large diesel engine, or a trunk piston engine or a two-stroke or a four-stroke internal combustion engine or a dual fuel engine being operable either in diesel or otto mode.

[0018] The invention is further concerned with a method for exchanging a fluid injector of a fluid injection device according to any of the preceding embodiments.

[0019] According to this invention the connection of the low pressure pipe is contained in a separate sleeve arranged around the injector. The exchange of the injectors is quick and easy as the injector has to be removed and moved back into the sleeve. The low pressure pipes do not have to be removed when removing the injector. The cylinder cover machining complexity is not increased since the supply and the drain connections are arranged in the sleeve around the injector. The different media's are separated by O-rings in the injector.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] In the following the invention will be described with reference to the accompanying schematic drawings.

Fig. 1 shows a section through a cylinder of an internal combustion engine

Fig. 2 illustrates an embodiment of the fuel injection device according to the invention as a sectional view.

Fig. 3 shows a section of a fuel injector according to the invention

Fig. 4 shows an alternative for attaching the collector element to the fuel injector and the cylinder cover.

Fig. 5a, 5b, 5c show a further embodiment of the

invention

DETAILED DESCRIPTION OF THE INVENTION

[0021] Fig. 1 shows, in a schematic illustration a first embodiment of a cylinder arrangement 100 according to the invention with the fuel injection device according to the invention for an internal combustion engine which is in the present example a longitudinally scavenged cross-head large diesel engine. The cylinder arrangement 100 according to Fig. 1 includes a cylinder 101 in which a piston 103 is arranged to be movable along a longitudinal cylinder axis 107 to and fro between a top dead centre position and a bottom dead centre position, wherein in the cylinder 101 a combustion chamber 104 is defined by a cylinder cover 102, by a cylinder wall 105 of the cylinder 101 and by a piston surface 106 of the piston 103. Only one charge-cycle valve 109 being here an outlet valve is provided in a gas exchange opening 110 of the cylinder cover 102 which gas exchange opening 110 is connected via a gas feeding conduct 111 to a not shown turbocharger assembly in a per se known manner. The charge-cycle valve 109 includes a valve disk 112 cooperating in the operation state with a valve seat 113 of the gas exchange opening 110 in such a way, that in a closed position of the charge-cycle valve 109, the combustion chamber 104 is sealed with respect to the gas feeding conduct 111, wherein in an open position of the charge-cycle valve 109 combustion gases can be fed out of the combustion chamber 104 to the turbocharger assembly.

[0022] In Fig. 2, the reference numeral 1 indicates a cylinder head of an internal combustion engine supporting a fuel injection device 2 by means of which high pressure fuel is injected into a cylinder of the engine in a way known as such. High pressure fuel provided by a common rail system (not shown) is delivered through a first connection element 7 to the fuel injection device 2.

At least one of a second, third, fourth and fifth connection element 3, 13, 23, 33 can be foreseen for the delivery of lubricant or cooling fluids or the discharge thereof. Each of the connection elements is connected to a common collector element 5. This collector element can in particular be configured as a sleeve. The collector element is disposed with a central bore for receiving a fuel injector 4 therein. The collector element and/or the fuel injector contain fluid passages 6, 16, 26, 36 for distributing the appropriate fluid to the appropriate point of use in the fuel injector.

[0023] Fig. 3 shows a section through a fuel injector 4. The fuel injector contains an injection nozzle 41, which in the assembled state protrudes somewhat into the combustion chamber, as shown in Fig. 2. The injection nozzle 41 is disposed with at least one fuel supply passage 42 for supplying high pressure fuel into the combustion chamber 104 as shown in Fig. 1. The injection nozzle 41 forms in its simplest form a portion of the housing 40 of the fuel injector. However, it may be advantageous that the injection nozzle 41 is configured as a separate part

due to the fact that the material of the injection nozzle 41 is subjected to the high temperatures prevailing in the combustion chamber 104, when the engine is in operational state. The fuel supply passage 42 of the injection nozzle is connected to a high pressure fuel supply reservoir 43, which extends at least partially in the injection nozzle element 41.

[0024] The injection nozzle element 41 is received in an injection nozzle holding sleeve 55, which is attached to the fuel injector body 56.

[0025] The fuel supply passage 42 can receive fuel from a fuel reservoir 44, which is also arranged in the fuel injector body 56 and can receive fuel from fuel supply conduit 45. The fuel reservoir 44 contains a moveable valve element 46. The valve element 46 can thus open and close a connecting passage 57 between the fuel reservoir 44 and the high pressure fuel supply reservoir 43. The valve element is disposed with a tip 49, which can be in contact with a seat 50 in the housing so as to close the connecting passage 57. In its closed state, the tip 49 rests on the seat 50 to interrupt any passage of fuel into the high pressure fuel reservoir 43. The closed state is shown in Fig. 3.

[0026] The valve element 46 is disposed with an end surface 47 subjected to a control fuel pressure and an intermediate surface 48, which is subjected to the fuel pressure present in the fuel reservoir 58. Furthermore a spring 59 is placed in the fuel reservoir 58. The spring acts on the intermediate surface 48 to keep the passage 57 closed by the valve element 46. The spring is wound around a guiding element 59, which is part of the valve element 46. The guiding element 59 terminates in the end surface 47. The guiding element is guided by a sleeve element 63. The sleeve element 63, the end surface 47 and the fuel injector body supporting the sleeve element 63 form a control space 64. The control space 64 is connected to the fuel supply conduit 45 by a throttling passage 65. The throttling passage 65 has a cross-section which is at most half the cross-section of the fuel supply conduit 45. Furthermore the control space 64 is connected to a control passage 66 leading to a control fuel passage 60. This control fuel passage 60 contains fuel. The control fuel passage has a radial passage 61 into which a displacement element 81 extends, which is operated by a solenoid 80. The radial passage connects to a circumferential passage 62, which forms a recess on the outer surface of the fuel injector body 56. The fluid passage 36 of Fig. 2 opens into this circumferential passage 62.

[0027] If the fuel pressure in the fuel reservoir 58 is the same as in the fuel reservoir 44 and in the control space 64, the tip 49 will remain seated on its seat 50.

The start of the fuel injection is controlled by the solenoid when the solenoid is activated. The displacement element 81 is pulled up and the pressure in the control chamber 64 will cause the valve element 64 to open. The fuel reservoir 58 is connected to the fuel reservoir 44 by a passage 51. The fuel pressure acts on the annular sur-

face 52 of the valve element 46 and a hydraulic force on the seat 50 during injection to push the valve element upwardly against the downward force exerted by the spring 40. Thus the spring is compressed and the valve element can lift from the seat 50 to supply fuel to the high pressure fuel reservoir 43.

The valve element 46 closes when the fuel pressure in the control space 64 is increased to such an extent, that the force acting on the end surface 47 in combination with the spring force becomes greater than the force acting on annular surface 52, thereby driving the valve element 46 back into its closed state.

[0028] Each time high pressure fuel is pumped through the supply conduit, this cycle repeats and an injection of fuel into the combustion chamber 104 occurs.

[0029] Furthermore a passage 70 for leakage fluids is foreseen. The passage 70 has a radial passage 71 through which the displacement element 81 extends, which is operated by solenoid 80. The radial passage 71 connects to a circumferential passage 72, which forms a recess on the outer surface of the fuel injector body 56. The fluid passage 26 of Fig. 2 opens into this circumferential passage 72.

[0030] In addition a passage 75 for the supply of lubricant and/or cooling fluid is foreseen. The passage 75 comprises a radial passage 76 and an axial passage 77. The radial passage 76 connects to a circumferential passage 78, which forms a recess on the outer surface of the fuel injector body 56. The fluid passage 6 of Fig. 2 opens into this circumferential passage 78. The lubricant and/or cooling fluid can be discharged through the discharge passage 85. The passage 85 has a radial passage 86 and an axial passage 87. The radial passage 86 connects to a circumferential passage 88, which forms a recess on the outer surface of the fuel injector body 56. The fluid passage 16 of Fig. 2 opens into this circumferential passage 88.

[0031] The collector element 5 is shown as well as the fluid passages 6, 16, 26, 36 leading to the respective connection elements 3, 13, 23, 33 shown in Fig. 2. The collector element 5 may be fixed to the cylinder cover by means of a screw connection 90. However, this is only one variant, it is also possible not to fix the collector element to the cylinder cover.

The collector element can be configured in particular as a sleeve, which can either be fixed to the cylinder cover, e.g. bolted to it, or it can be free to rotate and the angular position is fixed by the connection elements 3, 13, 23, 33 only. The connecting elements can be in particular configured as connecting pipes.

[0032] The fuel injector itself can either be bolted to the collector element or it can be directly fixed to the cylinder cover. In this case the collector element can be either free to rotate or be separately fixed to the cover. Such a variant is shown in Fig. 4. Again the parts having the same function as in the previous embodiment carry the same reference numbers and it is referred to the description of Fig. 2 or 3. The collector element 5 is attached

to the cylinder cover 102 by a screw connection 91. The fuel injector 4 is attached to the collector element 5 by a screw connection 92.

[0033] Fig. 5a, 5b, 5c show a further embodiment of the invention comprising a different type of fuel injector, which could be used with the same collector element as shown in Fig. 1 to 4. The parts having the same function as in Fig. 1 to 4 carry the same reference numbers and their function is not explained again. The valve element 46 is disposed with a fuel directing element 54 extending into the high pressure fuel reservoir 43. The fuel directing element contains a central passage 95, which provides a connection between high pressure fuel reservoir 43 and an intermediate fuel reservoir 96. The fuel directing element 54 can in addition be moved together with the valve element 46 to open and close the fuel supply passages 42.

[0034] Thus, according to this invention the connection of the low pressure pipe is done to an separate sleeve arranged around the fuel injector. The sleeve can remain on the cylinder cover even when the injector is removed. With this sleeve design the exchange of the fuel injectors is quick and easy, since the low pressure connection elements do not have to be removed when removing the fuel injector from the cylinder cover, e.g. for maintenance or replacement thereof. Thereby the cylinder cover machining complexity is not increased since the supply and the drain connections are integrated into the separate sleeve around the fuel injector. The different fluids are separated by sealing elements, preferably O-rings, disposed between neighbouring passages on the surface of the fuel injector and also above the uppermost fluid passage and below the lowermost fluid passage. Alternatively the sealing elements could be arranged in the sleeve.

[0035] From the foregoing it should not be construed, that the invention is in any way limited to the embodiment according to the figures. It can be implemented in many other different embodiments within the scope of the inventive idea and the attached claims.

Claims

1. A high pressure fluid injection device (2) for a common rail system for a large internal combustion engine, comprising a first connection element (7) for supplying high pressure fluid provided by a common rail system to the fluid injector (4) and at least a second connection element (3) for supplying a low pressure fluid to the fluid injector, **characterized in that** the fluid injection device includes a collector element (5) connectable to the fluid injector (4), whereby the collector element contains the second connection element (3) and the fluid injector (4) is in operation engaged with the collector element (5) to provide a fluid passage (6, 16, 26, 36) for the low pressure fluid.

2. A high pressure fluid injection device in accordance with claim 1, wherein the collector element (5) contains at least a third connection element (13, 23, 33) for a further low pressure fluid.

3. A high pressure fluid injection device in accordance with claim 1 or 2, wherein the collector element (5) is configured as a sleeve.

4. A high pressure fluid injection device in accordance with one of the preceding claims, wherein the sleeve has a central bore of at least partial conical configuration.

5. A high pressure fluid injection device in accordance with one of the preceding claims, wherein the pressure of the high pressure fluid is in the range of 600 to 2000 bar.

6. A high pressure fluid injection device in accordance with one of the preceding claims, wherein the pressure of the low pressure fluid is at most 10 bar.

7. A high pressure fluid injection device in accordance with one of the preceding claims, wherein the high pressure fluid is a fuel.

8. A high pressure fluid injection device in accordance with one of the preceding claims, wherein the low pressure fluid is one of a lubricant or a cooling fluid.

9. A high pressure fluid injection device in accordance with one of the preceding claims, wherein the fluid injector is removable from the collector element.

10. An internal combustion engine (100), including a cylinder (101), in which a piston (103) is arranged to be movable along a longitudinal cylinder axis (105) to and fro between a top dead centre position and a bottom dead centre position, wherein in the cylinder (101) a combustion chamber (104) is defined by a cylinder cover (102), by a cylinder wall (105) of the cylinder (101) and by a piston surface (106) of the piston (103) including a high pressure fluid injection device (2) in accordance with one of the preceding claims.

11. An internal combustion engine according to claim 10, wherein the combustion engine is a crosshead engine, in particular a crosshead large diesel engine.

12. An internal combustion engine according to claim 10, wherein the combustion engine is a trunk piston engine.

13. An internal combustion engine according to anyone of claims 10 to 12,

wherein the combustion engine is a two-stroke or a four-stroke internal combustion engine.

14. An internal combustion engine according to anyone of claims 10 to 13, 5
wherein the combustion engine is a dual fuel engine being operable either in diesel or otto mode.
15. A method for exchanging a fluid injector of a fluid injection device according to any of claims 1 to 9. 10

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Fig.1

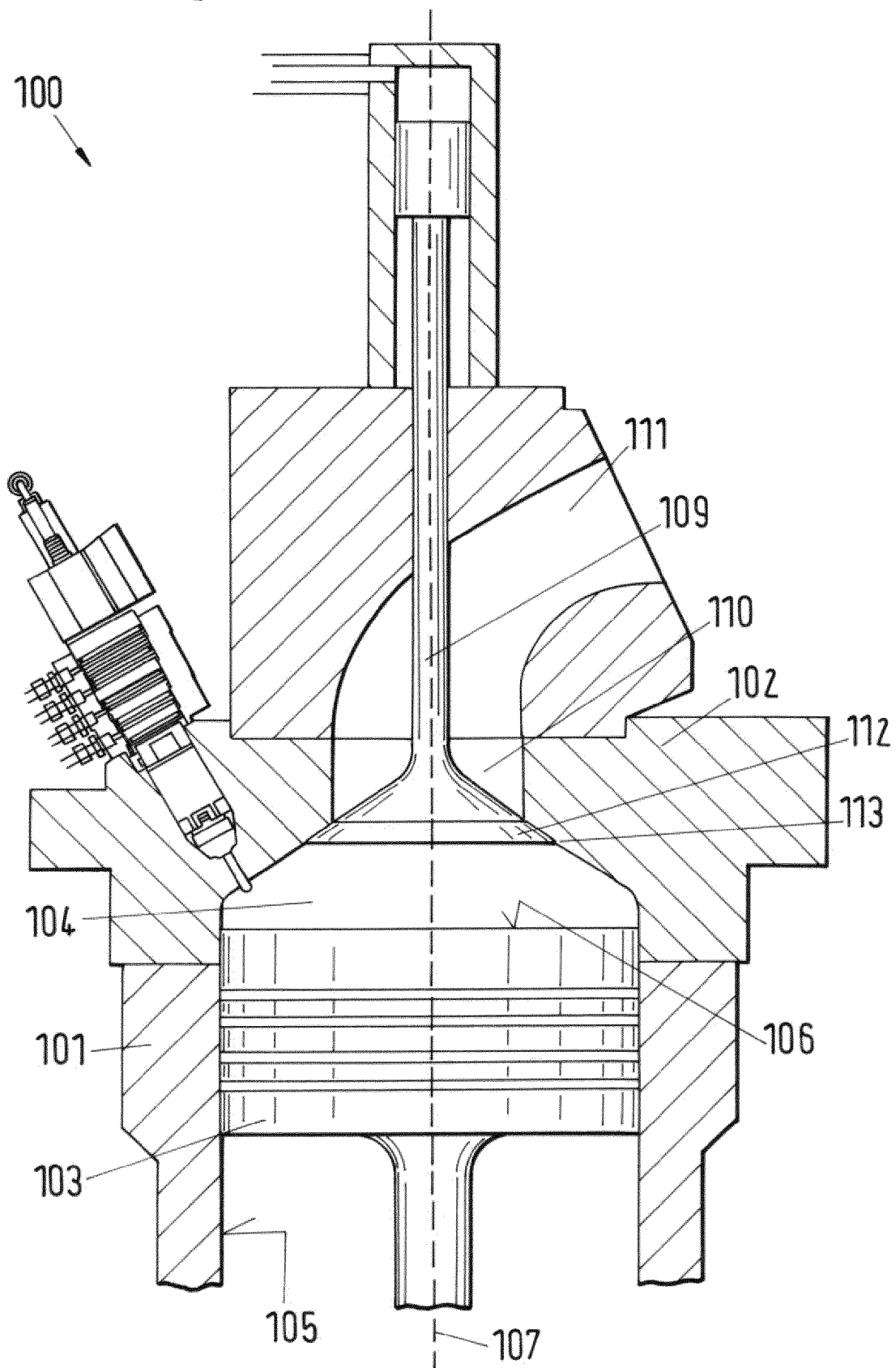


Fig.2

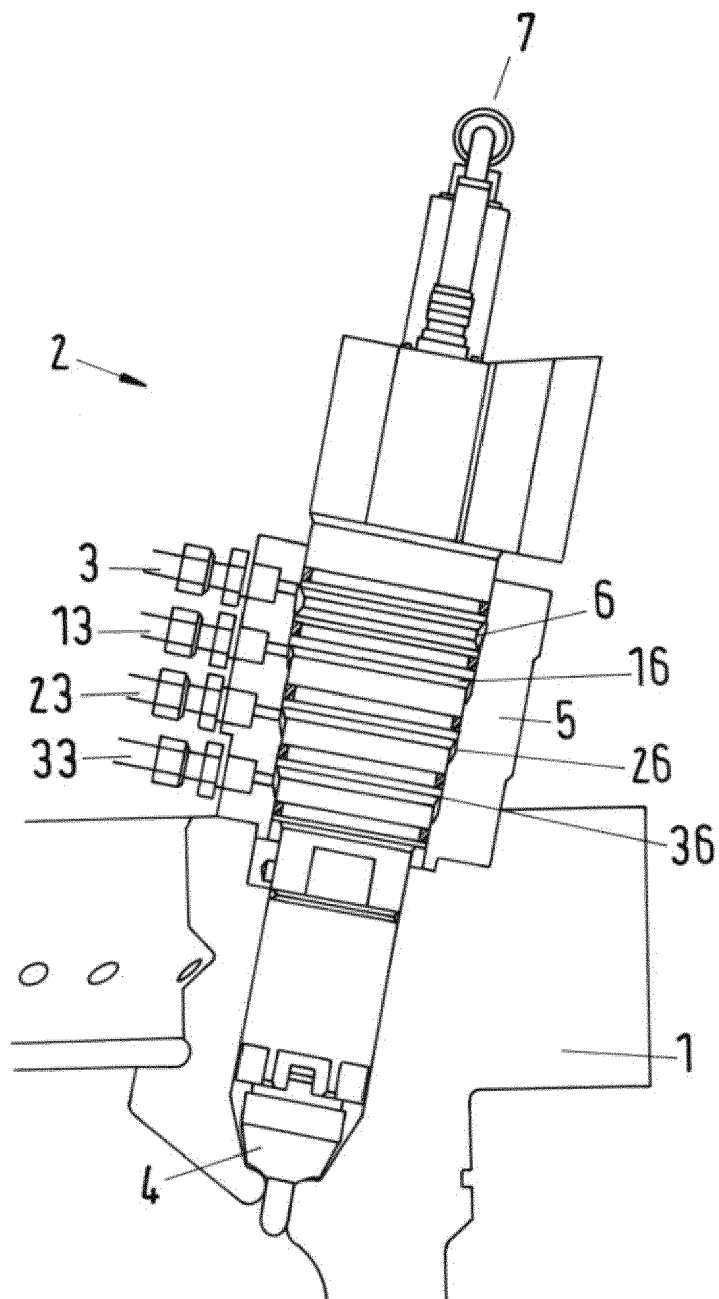


Fig.3

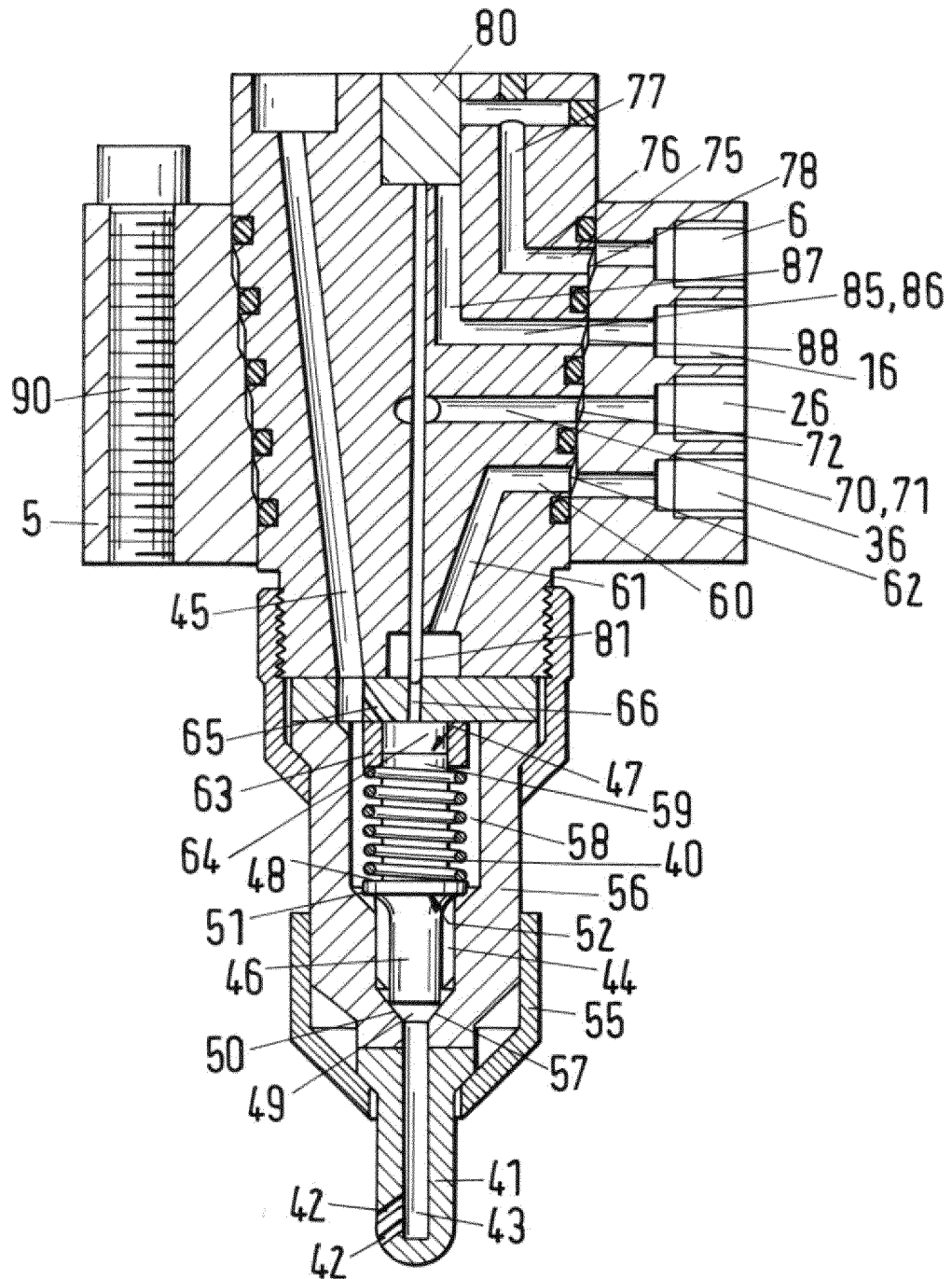


Fig.4

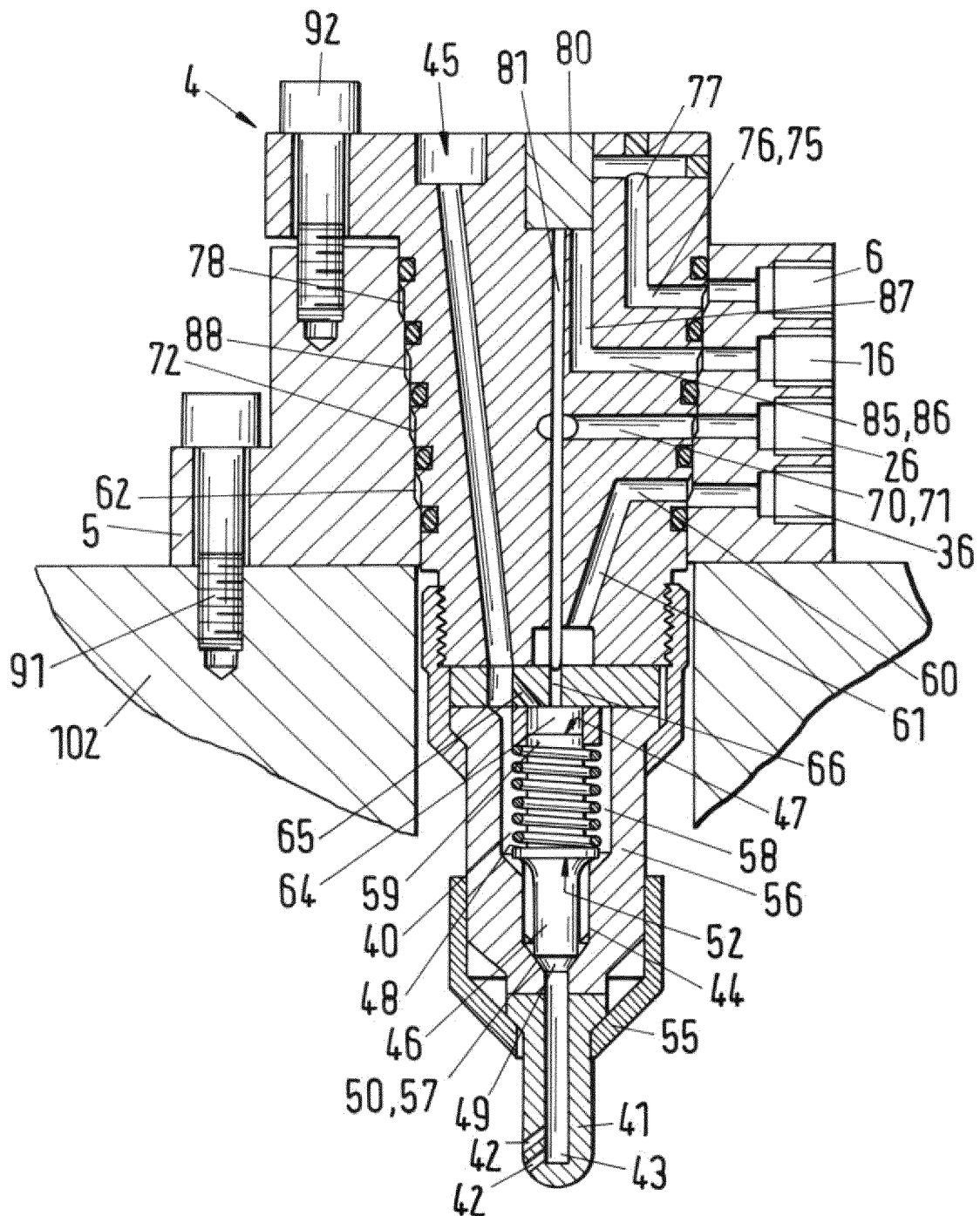


Fig.5a

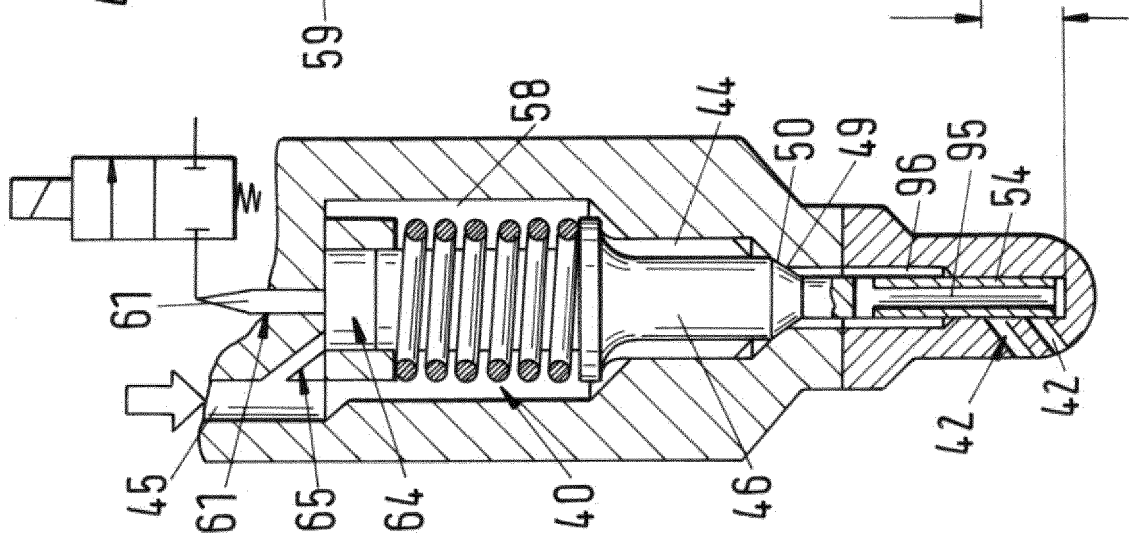


Fig.5b

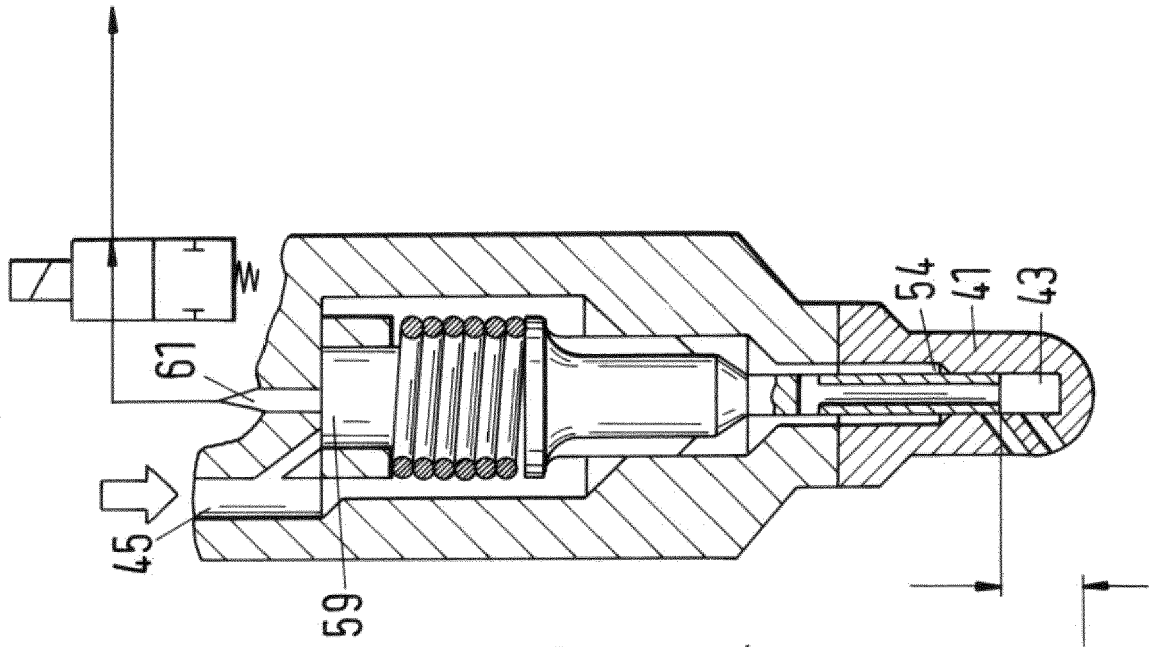
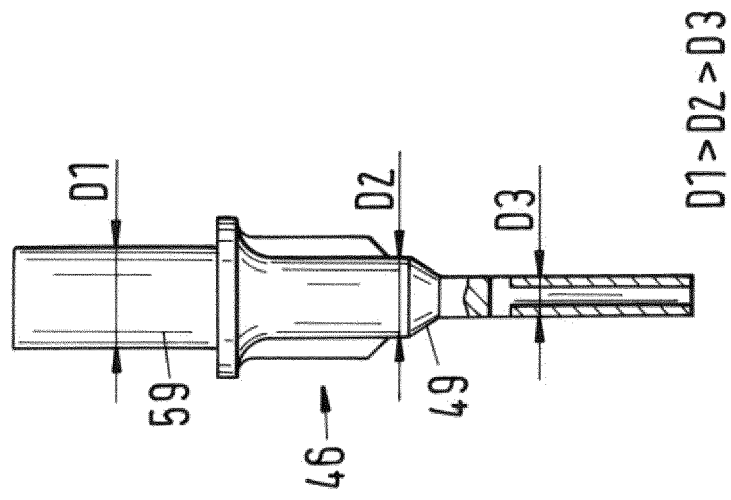


Fig.5c



$$D1 > D2 > D3$$



EUROPEAN SEARCH REPORT

Application Number
EP 12 15 5896

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 27 April 2012	Examiner Godrie, Pierre
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 12 15 5896

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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